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EXPERIMENTS

AT THE

AGRICULTURAL STATION,

LYALLPUR,

PUNJAB.

SEPTEMBER 1920.

Lahore :
Printed by the Superintendent, Government Printing Punjab.
1921.

PREFACE.

This little book is chiefly intended for the visitor at the Farm ; but it is hoped that it will be useful to any one interested in Punjab Agriculture. It is not intended as a complete record or summary of the work which has been done at Lyallpur ; but an attempt is made to explain shortly the chief problems which are being attacked at present, to summarise the results bearing on these problems, to explain the present state of our knowledge, and to give an account of the experiments now being carried on. Some of the tables of results may appear rather indigestible for general consumption. It is felt, however, that any further condensation would frustrate our desire to present, not only the conclusions reached, but also the data on which they depend. The bare conclusions are presented to the public in short leaflets which are distributed free in large numbers. Should any one desire more detail than is given here, it is to be found to some extent in the annual reports ; or the very detailed farm records would readily be made available to any interested enquirer.

O. T. FAULKNER.

Lyallpur,

September 1920.

The important work done in the Botanical Section is not dealt with in this book.

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GLOSSARY, etc.

Yields throughout are quoted in maunds (and decimal parts of a maund) per acre.

1 maund = 40 seers = 82·28 lbs.

1 square of land (in the Chenab Colony) = 25 killas = 27·8 acres.

1 killa = 1·11 acres (220′ × 220′).

1 acre = 8 kanals = 160 marlas = 160 square poles.

Bhusa—Straw broken under bullocks' feet in the course of thrashing.

In these tables " yield of bhusa " = total weight of crop shortly after cutting *minus* the weight of cleaned grain.

Desi cotton.—The local Indian cottons ; includes several allied species.

American cotton—Gossypium hirsutum.—The crops grown in the Punjab are acclimatized descendants from upland seed introduced into various pars of India many years ago. The plants now behave very differently in the field from the produce of newly imported seed.

Guara—Cyamopsis Psoraloides—a strong growing hardy Legume grown on canal irrigated land for green summer fodder ; usually mixed with *chari* (*Sorghum Vulgare*).

Kallar.—Alkaline incrustation on soil, or an excess of salt near the surface of the soil sufficient to reduce its fertility.

Kiari.—In the Indian method of irrigation the field is divided into several parts by small banks or ridges and each compartment thus formed is flooded separately from the watercourse. The compartment is called " *Kiari.* "

Senji—Melilotus Parviflora.—Leguminous fodder crop sown in October, often between the plants of other standing crops, ready for cutting in February and March.

Sohaga.—A heavy plank drawn (by one or two pairs of bullocks over the soil when preparing seed-bed or after sowing in order to crush clods, or to consolidate the land, or to level it for the sake of rapidity and economy in irrigation.

Wari.—The water from a canal watercourse irrigating usually about 300 or 400 acres is distributed to each landholder in rotation according to his area. The whole rotation, usually taking about 10 days, is termed a " Wari."

Zamindar.—Lit. Land-owner ; but often used in the Punjab for any farmer whether he owns his land or occupies it as tenant or lease-holder.

RECORD OF SEASONS AT LYALLPUR.

Year.	Summer rainfall in inches.	Month of chief rainfall.	Sugar-cane.	Maize.		American Cotton		Toria.		First frost.	Winter rainfall in inches.	Month of chief rainfall.	Wheat.		Gram
			Yield of gur.	Yield.	Remarks.	Yield.	Remarks.	Yield.	Remarks.				Yield.	Remarks.	Yield.
1909-10	20·4	July and September.	Poor	...	...	Good	...	...	...	Dec. 5.	2·1	December and January.	Good	...	...
1910-11	15·5	August	Good	Average	...	Good	...	...	...	Dec. 17.	4·2	March	Poor	Rain at flowering time.	...
1911-12	5·5	...	Poor	Good	...	Below average.	...	Very good.	...	Nov. 23.	2·1	January	Good	No rust	Poor.
1912-13	7·2	...	Average	Below average.	...	Very good.	...	Good	...	Nov. 19.	6·0	February and March.	Good	..	Very good.
1913-14	17·7	August	Good	Good	...	Good	...	Average	...	Dec. 14.	5·7	February and March.	Below average; shrivelled.	Rust bad	Poor.
1914-15	17·4	July	Poor	Failure	Excessive July rain, hail in October, borer attack	Poor	Rain at flowering, early frost.	Very poor.	Hail and early frost.	Dec. 6.	4·8	October and March.	Below average; shrivelled.	Rust early and bad.	Poor.
1915-16	2·2	...	Average	Average	...	Above average.	...	Poor	...	Dec. 6.	1·0	...	Good	Rust very slight.	Good.
1916-17	11·0	August	Good	Poor	Due to borer and white ants.	Average	...	Good	...	Nov. 27	·8	...	Average	Weather favourable; irrigation supplies deficient.	Good.
1917-18	24·7	August and September.	Fair	Poor	Excessive rain.	Average	...	Fair	...	Nov. 11.	·9	...	Average	Weather favourable; Late rust.	Good.
1918-19	5·9	August	Good	Good	...	Good	...	Good	..	Nov. 13.	2·4	January	Good	...	Average
1919-20	9·7	August	Very good.	Good	...	Partial failures.	...	Very good.	...	Dec. 1.	2·4	...	Very good	No rust, winter warm spring cool.	Very good.

NOTE.—Winter = October 1st to March 31st.

VARIETAL TESTS.

One of the most important parts of the work at the Lyallpur Farm has been the testing of different varieties of the common crops of the district, especially of wheat and cotton. These varieties have mostly been separated by the Economic Botanist from the mixtures of types found in the ordinary crops of the district. After preliminary tests, the more useful ones are handed over to the farm for thorough testing on a large scale. Where one variety is found useful and recommended for general adoption, many are tested just so long as is necessary to give a definite result, are rejected and soon are forgotten. The tests are carried out on a wide scale under varying conditions. Definite results have been obtained and varieties which have survived these tests, have done remarkably well when given out to the farmers in the neighbouring districts. The American cotton 4 F (first given out in 1913) had by 1919 replaced the country cotton over the whole area for which it was recommended, an area of about 500,000 acres per annum. Similarly the wheat Punjab 11 is grown on an area of several hundred thousand acres annually ; and these areas are still increasing. Pure selected seed for these two crops is sold by the Agricultural Department every year, sufficient for a very large area (several hundred thousand acres in the case of the cotton). Condensed statements of a few of the more important of these experiments are given in Tables 1—5.

Table No. 1.

COMPARATIVE TESTS OF PUNJAB 17 AND PUNJAB 11 WHEATS.

YEAR.	Square and plot.	Names of varieties compared.	Number of tests.	Number of Irrigations.	Total area.	Average outturn of grain per acre.	Apparent superiority (+) or inferiority (−) of Punjab 17 compared to Punjab 11 in grain.		Average outturn of Bhusa per acre.	Apparent superiority (+) or inferiority (−) of Punjab 17 compared to Punjab 11 in Bhusa.	
					Acres.	Maunds.	Maunds.	Per cent.	Maunds.	Maunds.	Per cent.
1913-14 ...	26-A ...	Punjab 11 ...	4	2	2	18·1	−1·9	−10·5	36·5	−·8	−2
	3 and 4 ...	Punjab 17 ...			2	16·2			35·7		
	Tenants ...	Punjab 11 ...	7	...	3·3	11·1	+·7	+6	...	...	...
		Punjab 17 ...			3·3	11·8					
1914-15 ...	26 A/1 ...	Punjab 11 ...	2	4	2	21·3	−·6	−3	69·0	+7·1	+10
		Punjab 17 ...			2	20·7			76·1		
	25 A/4 ...	Punjab 11 ...	2	3	2	18·9	−1·0	−5	41·6	+1·8	+4·5
		Punjab 17 ...			2	17·9			43·4		
	Tenants ...	Punjab 11 ...	7	...	3·4	11·0	−·7	−6	..	...	...
		Punjab 17 ...			3·4	10·3					
		Punjab 11 ...	3	...	1·6	11·5	−1·0	−9	...	...	...
		Punjab 17 ...			1·6	10·5					
1915-16 ...	26 A/2 ...	Punjab 11 ...	2	4	1	28·7	−·2	−7	49·9	−5·6	−11
		Punjab 17 ...			1	28·5			55·5		
	26 A/1 ...	Punjab 11 ...	2	5	1	22·1	−3·3	−15	42·2	−5·1	−14
		Punjab 17 ...			1	18·8			37·1		
1917-18 ...	Tenants ...	Punjab 11 ...	5	...	2·6	23·5	−3·4	−14	...	...	...
		Punjab 17 ...			2·6	20·1					

TABLE No. 2.

Table No. 2.

COMPARATIVE TESTS OF PUSA 12 AND PUNJAB No. 11 WHEATS.

YEAR.	Square and plot.	Names of varieties compared.	No. of tests.	No. of irrigations.	Total aree.	Average outturn of grain per acre.	Apparent superiority (+) or inferiority (−) of Pusa 12 compared to Punjab 11 in grain.		Average outturn of Bhusa per acre.	Apparent superiority (+) or inferiority (—) of Pusa 12 compared to Punjab 11 in Bhusa.	
					Acres.	Maunds.	Maunds.	Per cent.		Maunds.	Per cent.
1913-14 ...	26 A	Punjab 11 ...	4	2	2	18·1	...	...	36·5	−1·3	−4
	3, 4,	Pusa 12 ...			2	18·1			35·2		
	Tenants ...	Punjab 11 ...	4	...	2	4·6	−·2	−4	8·2	−1·8	−22
		Pusa 12 ...			2	4·4			6·4		
1914-15 ...	26 A	Punjab 11 ...	2	4	1	21·3	+·8	+4	69·0	−14·2	−20·5
	1 ...	Pusa 12 ...			1	22·1			54·8		
	26 A	Punjab 11 ...	2	3	1	18·9	+·1	...	41·6	+1·4	+3
	4 ...	Pusa 12 ...			1	19·0			43·0		

	Tenants ...	Punjab 11 ...	2	...	·9	14·5	+ 1·8	+ 12	86·5	−2	−3
		Pusa 12 ...			·8	16·3			64·5		
		Punjab 11 ...	6	...	3	17·3	− 2·3	− 13	...	...	...
		Pusa 12 ...			3	15·0					
		Punjab 11 ...	5		2·6	13·0	− ·6	− 5	...	...	...
		Pusa 12 ...			2·6	12·4					
1916-16 ...	26 A / 2 ...	Punjab 11 ...	2	4	2	28·7	− 2·2	− 8	49·9	−1·7	−4
		Pusa 12 ...			2	26·5			48·2		
	26 A / 1 ...	Punjab 11 ...	2	5	2	22·1	+ ·1	...	42·2	+2·1	+5
		Pusa 12 ...			2	22·2			44·3		
	Tenants ...	Punjab 11 ...	2	4	2	15·1	+ 2	+ 13	28·0	+9·9	+35
		Pusa 12 ...			2	17·1			37·9		
		Punjab 11 ...	2	4	2	12·0	+ 1·7	+ 14	23·0	+3·8	+16·5
		Pusa 12 ...			2	13·7			26·8		
1917-18 ...	Tenants' area	Punjab 11 ...	12	...	3	8·2	+ 1·3	+ 16	...	...	...
		Pusa 12 ...			3	6·9					
1918-19 ...	32 / B ...	Punjab 11 ...	6	2	1·1	25·4	− 1·1	− 4	57·3	− 10·5	−18
		Pusa 12 ...			1·1	24·3			46·8		
	32 / B ...	Punjab 11 ...	6	3	1·1	27·4	− 2·4	− 9	57·7	−12·5	−22
		Pusa 12 ...			1	25·0			45·2		

Table No. 3.

COMPARATIVE TESTS OF PUNJAB 8 A AND PUNJAB 11 WHEATS.

YEAR.	Square and plot.	Names of varieties compared.	Number of tests.	Number of irrigations.	Total area.	Average outturn of grain per acre.	Apparent superiority (+) or inferiority (−) of 8 A compared to Punjab 11 in grain.		Average outturn of Bhusa per acre.	Apparent superiority (+) or inferiority (−) of 8 A compared to Punjab 11 in Bhusa.	
					Acres.	Maunds.	Maunds.	Per cent.	Maunds.	Maunds.	Per cent.
1916-17 ...	$\frac{26}{A_2}$ ...	Punjab 11 ...	2	4	2·0	21·4	+ ·4	+2	44·5	+5·8	+13
		8 A ...			2·0	21·8			50·3		
	$\frac{26}{A_3}$ ...	Punjab 11 ...	2	3	2·0	24·6	−1·0	−4	47·4	−·5	−1
		8 A ...			2·0	23·6			46·9		
	Tenants ...	Punjab 11 ...	8	...	4·0	15·3	+1·7	+11	...	...	...
		8 A ...			4·0	17·0					
1917-18 ...	$\frac{26}{A_3}$ ...	Punjab 11 ...	2	3	2·0	14·7	+1·6	+11	32·4	−1·4	−4
		8 A ...			2·0	16·3			31·0		

	$\frac{26}{A_4}$ ...	Punjab 11 ... 8 A ...	2	3	2·0 2·0	23·6 23·7	+ ·1		42·2 52·9	+10 7	+25
	$\frac{43}{A}$ ...	Punjab 11 ... 8 A ...	6	3	3·0 3·0	11·5 15·8	+ 4·3	+ 37	26·9 37·2	+10·3	+38
	Tenants ...	Punjab 11 ... 8 A ...	7	...	3·5 3·5	12·5 12·6	+ ·1	+1	...	...	...
1918-19 ...	$\frac{43}{A_{7, 8, 9}}$ ...	Punjab 11 ... 8 A ...	8	3	·4 ·4	25·8 25·8	...	...	...	...	...
	$\frac{26}{A_1}$ ...	Punjab 11 ... 8 A ...	2	3	2·0 2·0	25·2 27·3	+ 2·1	+8	46·9 51·6	+ 4·7	+10
	$\frac{26}{A_4}$	Punjab 11 ... 8 A ...	2	3	2·0 2·0	18·8 18·4	− ·4	−2	30·7 31·3	+ 6	+ 2
	Tenants ...	Punjab 11 ... 8 A ...	18	...	4·6 4·6	20·3 19·2	−1·1	−5	...	...	..
1919-20 ...	$26\frac{A_2}{1 \text{ to } 3}$	Punjab 11 ... 8 A ...	6	3	1·5 1·5	34·2 34·2		..	63·3 65·0	+1·7	+3
	$28\frac{A_2}{1 \text{ to } 3}$	Punjab 11 ... 8 A ...	6	3	1·5 1·5	21·5 21·0	− ·5	−2	31·1 32·4	+1·3	+ 4

Table No. 3—*concluded.*

COMPARATIVE TESTS OF PUNJAB 8 A AND PUNJAB 11 WHEATS—CONCLUDED.

YEAR.	Square and plot.	Names of varieties compared.	Number of tests.	Number of irrigations.	Total area.	Average outturn of grain per acre in maunds.	Apparent superiority (+) or inferiority (−) of 8 A compared to Punjab 11 in grain.		Average outturn of Bhusa per acre in maunds.	Apperent superiority (+) or inferiority (−) of 8 A compared to Punjab 11 in Bhusa.	
					Acres.	Maunds.	Maunds.	Per cent.	Maunds.	Maunds.	Per cent.
1919-20 ...	32/C 1, 3, 5	Punjab 11 ...	9	2	1·3	30·1	−·6	−2	56·8	+4·8	+8
		8 A ...			1·3	29·5			61·6		
	32/C 2, 4, 6	Punjab 11 ..	9	3	1·3	32·1	−1·6	−5	51·3	+1·4	+3
		8 A ...			1·3	30·1			52·7		
	32/B 1, 3, 5	Punjab 11 ...	9	2	1·3	24·0	+1·1	+5	40·5	+3·5	+9
		8 A ..			1·3	25·1			44·0		
	32/B 2, 4, 6	Punjab 11 ...	9	3	1·3	24·2	−·2	−1	40·0	−4·9	−12
		8 A ...			1·3	24·0			44·9		

Tenants ...	Punjab 11 ... 8 A ...	6	2	1·5 1·5	23·2 22·1	−1·1	−5		...	...
	Punjab 11 ... 8 A ...	6	2	1·5 1·5	20·3 21·9	+1·6	+8	...	...	...
	Punjab 11 ... 8 A ...	8	2	2·0 2·0	23·5 27·7	−·8	−3	...	...	...
	Punjab 11 ... 8 A ...	8	2	2·3 2·2	25·4 25·3	−·1	...	...	...	...
	Punjab 11 ... 8 A ...	8	3	2·0 2·0	24·9 24·6	−·3	+1	...	...	...
	Punjab 11 ... 8 A ...	8	3	2·1 2·1	34·8 35·2	+·4	+1	...	...	...
	Punjab 11 ... 8 A ...	6	3	1·5 1·5	23·7 22·4	−1·3	−5	...	...	...
	Punjab 11 ... 8 A ...	6	3	1·5 1·5	20·3 19·7	−·6	=3	...	...	...

Table No. 4.

COMPARATIVE TESTS OF ROSEUM AND MOLLISONI COTTONS ON TENANTS AREA.

YEAR.	Names of varieties compared.	No. of tests.	No. of irrigations.	Total of area.	Average outturn of Kapas per acre.	Apparent superiority (+) or inferiority (−) of Roseum compared to Mollisoni.	
				Acres.	Maunds.	Maunds.	Per cent.
1916-17 ...	Mollisoni ...	8	...	2·0	13·7	−1·7	−12
	Roseum ..			2·1	12·0		
1917-18 ...	Mollisoni ...	10	2 average	2·3	11·0	−2·5	−22
	Roseum ...			2·3	8·5		
1918-19 ...	Mollisoni ...	12	4 average	3·0	11·6	−·2	−2
	Roseum ...			3·0	11·4		

Table No 5.

COMPARATIVE TESTS OF 285 F AND 4 F COTTON IN TENANTS AREA.

YEAR.	Names of varieties compared.	No. of tests.	No. of irrigations.	Total area.	Average outturn of kappas per acre.	Apparent superiority (+) or inferiority (−) of 285 F compared to 4 F.	
				Acres.	Maunds.	Maunds.	Per cent.
1918-19	4 F	8	6	2·1	13·0	−2·2	−17
	285 F		average	2·1	10·8		
1919-20	4 F	14	4	3·3	3·2	+1·6	+50
	285 F		average	3·3	4·8		
	4 F	14	7	3·5	5·1	+·4	+8
	285 F		average	3·5	5·5		

Sowing cottons in lines.

COTTON in the Punjab was previously invariably sown broadcast and part of the work at Lyallpur has been the testing of the method of sowing in lines; studying various minor problems connected with it; and devising cheap implements, in the shape of the marker, Lyallpur Drills and Hoes, for sowing in lines and also for interculturing the cotton after sowing. The advantages of sowing in lines are not only that a more even plant is thus secured; but also the crop can afterwards be intercultured much more cheaply. When cotton is sown broadcast by zamindars, there are always some portions of the field wasted in large bare patches. A broadcast crop can only be intercultivated by bullock power once or twice at one certain stage of its growth; and even this is at the expense of some damage to the plants. To intercultivate a crop by hand takes one man several days. A crop in lines, on the other hand, can easily be intercultivated as often as required, from the time the plants appear above ground until the time of flowering; and this with a minimum of damage to the plants. The process of sowing in lines has passed the experimental stage and many thousands of acres are sown in lines in the district every year. Comparisons of broadcast and line sowing are, however, continued for the sake of demonstration. The results of such experiments are given in Table No. 6. On the average of all experiments up to date, sowing in lines has increased the yield by over 40 per cent. The relative improvement due to the sowing in lines is greater, the less the land has been previously cultivated and the more it is infested with weeds. The difference is thus generally much more marked on the "tenants area" than on the land under "direct cultivation." Drills are also sold for use with maize and wheat; but in these cases the object is more the saving of labour than increase of yield. In experiments with these crops, similar yields have been obtained from the crops sown by the best country methods and with the drills.

TABLE No. 6.

Table No. 6.

METHODS OF SOWING OF COTTON.

YEAR.	Square and field.	Variety of cotton.	Treatment.	No. of plots.	Area of each plot.	No. of waterings after sowing.	No. of hoeings.	Average yield per acre.	Average increase (+) or decrease (−) apparently due to sowing in lines and frequent inter-culture.	
					Acre.			Mds.	Mds.	Per cent.
1916 ...	10	Desi ...	Lines ...	4	¼	5	6	9·2	+2·2	+31
			Broadcast ...	4		6	1	7·0		
1917 ...	10 A	Desi ...	Lines ...	4	¼	1	14	9·9	+2·6	+36
			Broadcast ...	4		1	1	7·3		
	32 B	American ...	Lines ...	4	¼	1—3	9	10·8	+·3	+3
			Broadcast ...	4		1—3	1	10·6		
	13/14	American ...	Lines ...	2	¼	2	8	9·8	+1·5	+18
			Broadcast ...	2		3	1	8·3		
	13/17	American ...	Lines ...	2	¼	2	8	11·3	+5·0	+80
			Broadcast ...	2		3	1	6·3		
	19/1	Desi ...	Lines ...	2	¼	1	8	10·7	+6·0	+128
			Broadcast ...	2		1	1	4·7		

		20/5	Desi	...	Lines ...	2	¼	1	8	14·3	+·9	+7
					Broadcast ...	2		1	1	13·4		
	...	10	Desi	...	Lines ...	4	¼	4	6	10·2	+2·1	+26
					Broadcast ...	4		5	1	8·1		
		32 C	American	...	Lines ...	6	½	5—7	6	8·8	+1·4	+19
					Broadcast ...	6		5—7	1	7·4		
		6/6	American	...	Lines ...	2	¼	4	3	13·3	+6·5	+96
					Broadcast .	2		5	1	6·8		
		6/5	Desi	...	Lines ...	2	¼	5	5	14·4	+6 2	+76
					Broadcast ...	2		6	1	8·2		
1919	...	6/25	Desi	...	Lines ...	1	¼	4	4	14·3	+2·6	+22
					Broadcast ...	1		4	1	11·7		
		6/13	Desi	...	Lines ...	1	¼	5	4	15·9	+4·1	+38
					Broadcast ...	1		5	1	11·8		
		6/28	4 F	...	Lines ...	1	¼	4	4	1·7*	+·5	...
					Broadcast ...	1		4	1	1·2*		
		6/18	4 F	...	Lines ...	1	¼	5	4	2·9*	−·1	...
					Broadcast ...	1		5	1	3·0*		

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* American cotton crop on most fields at Lyallpur practically failed in 1991.

Rotations.

The problems connected with the effect of different rotations on the fertility of the soil are everywhere very important; but they are especially so in the Punjab Canal Colonies. For here two very different classes of crops are regularly grown-tropical crops in the summer season, and the crops of temperate climates in the winter; and the perennial irrigation allows of great variation in the proportions and combinations of these crops. For instance, on the average the canal lands are cropped about once a year; but many fields regularly grow four crops in three years or even three crops in two years. There is no doubt that the intensity of cropping affects the yield of each crop very greatly, and is intimately connected with every problem in farming practice. It directly affects such matters as the best amount of water to apply, the results from manuring, the returns from good cultivation, and the prevalence of weeds. The amount of water, the amount of manure, or the number of cultivations which it is best to give under one system of cultivation will not necessarily be the best if the same land be more or less intensively cropped. The maximum intensity which is possible naturally depends on the water supply; and on a large scale this could only be varied by constructional works. But even with a fixed supply there is room for considerable variation: for a large area of crops demanding little water, or a smaller area of crops demanding more water, may be grown; or a part of the farm may be more heavily cropped than the remainder or a medium intensity adopted throughout. The experimental study of the economics of different rotations of crops is rendered much more difficult by this relationship with the water supply, and it cannot yet be taken up on the scale that it merits. A start has, however, been made in this direction on square 26. This land was cropped for eight years on a rotation of wheat, wheat, toria, cotton. This cropping has shown that the fields are very comparable in the way in which they are arranged, though there is a difference in fertility of the order of 15 or 20 per cent. in the two sides. The yields for the eight years are given in Table No. 7. To judge from the yields of wheat and toria there is little sign of any reduction in fertility. But the yields of cotton have been very poor in the later years. In this connection it must be noted that cotton here follows toria after a few weeks interval only, whereas the other crops follow summer fallows. The figures are good examples of the yields that can be obtained here without manuring and with moderate fallowing and watering, and good cultivation.

The square has now been divided into four parts, each separately under a different rotation; and the rotations are such as will make very different demands on the water supply and on the fertility of the soil. Each block consists of three fields and the rotations are all three-year rotations.

Block A-1.	First year	Summer	Fallow.
		Winter	Wheat.
	Second year	Summer	Fallow.
		Winter	„
	Third year	Summer	Cotton.
		Winter	...

This rotation gives an intensity of only 66 per cent.

Block A·2.	First year	Summer	Fallow.
		Winter	Wheat.
	Second year	Summer	Fallow.
		Winter	Gram.
	Third year	Summer	Cotton.
		Winter	...

This rotation gives 100 per cent. intensity but differs from that previously followed in that cotton follows the leguminous crop gram, which is considered to be less exhaustive than toria.

Block A·3.	First year	Summer	Guara-Ploughed in for green manure.
		Winter	Wheat.
	Second year	Summer	Fallow.
		Winter	Toria.
	Third year	Summer	Cotton.
		Winter	...

Cotton here follows toria as previously. The important difference is that now the land is green manured every three years; the intensity (including the green manure crop) is 133 per cent.

Block A-4.	First year	Summer	Fallow.
		Winter	Wheat.
	Second year	Summer	Chari and Guara (for fodder).
		Winter	Gram.
	Third year	Summer	Cotton (receiving farm yard manure 10 tons per acre.)
		Winter	Senji (for fodder).

The intensity is 166 per cent. The quantity of manure roughly corresponds to the amount resulting from feeding the two fodder crops to cattle.

Table No. 7.

SQUARE 26, 1912—1920.

—	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	1918-19.	1919-20.	Average.
	(A_1)	(A_2)	(A_3)	(A_4	(A_1)	(A_2)	(A_3)	(A_4)	
Toria after Wheat A	11·9	12·2	6·3	7·7	12·5	8·8	10·0	8·5	9·4
B		13·0	5·0	10·3	15·1	14·1	11·7	10·4	11·4
	(A_4)	(A_1)	(A_2)	(A_3)	(A_4)	(A_1)	(A_2)	(A_3)	
Cotton after Toria A	14·5	3·7*	4·9	7·5	5 5	5·7	2·2	·8†	4·4
B			4·9	10·2	7 0	7·1	2·5	2·2	5·7
	(A_3)	(A_4)	(A_1)	(A_2)	(A_3)	(A_4)	(A_1)	(A_2)	
Wheat after Cotton A	24·6	17·2	18·7	27·4	17·8	19·7	25·0	35·0‡	23·2
B	27·6	21·2	22·7	28·6	29·4	25·7	24·0	34·8‡	26·7
	(A_2)	(A_3)	(A_4)	(A_1)	(A_2)	(A_3)	(A_4)	(A_1)	
Wheat after Wheat A	21·6	14·5	16·7	20·3	19·9	10·7	15·4	21·1‡	17·5
B	24·5	17·0	20·4	21·7	21·1	20·1	19·0	21·4‡	20·6

* Low yield due to disease.
† Low yield partially due to disease.
‡ In this year block A_1 was sown later than A_2.

Manurial Experiments.

A number of experiments, already carried out, have led to the following broad conclusions in regard to the use of manures under the local conditions :—

Gypsum generally caused no increase in the yield of any crop.

Phosphatic manures fail to cause any marked increase in the yield from common crops grown in rotations of 100 per cent. intensity.

Liming apparently causes small increases in yield of wheat and gram ; which in the experiments referred to were sown in land which had been fallow for several months.

Nitrogenous manures, applied in heavy dressings to crops grown in the ordinary rotations of 100 per cent. intensity, give the following results :—

On gram, no effect.

On wheat, small increases which could hardly cover the cost of manure even if it were very cheap.

On toria and cotton the effect is considerable in certain years.

On sugarcane and maize the effect is normally very considerable.

Farmyard Manure—Has throughout appeared to behave in exactly the same way as the purely nitrogenous manures It is the cheapest and only common means of directly adding to the supply of nitrogen in the soil.

It is evident that the results from the application of manure depend greatly on the intensity of cropping and it would be on very heavily cropped land that manuring would pay best. In square 27 two blocks F-1 and F-2 have been laid down for permanent manurial experiments under the following rotations :—

F-1 Maize, Wheat (or barley), Cotton.

F-2 Maize, Senji, Cotton.

These rotations give 150 per cent, intensity of cropping and the only fallow period is that of about 5 months between the cotton and maize crops. The manures are applied to the maize and cotton crops, *i.e.*, once a year. The quantities of artificial manures are such as to contain roughly the same amount of nitrogen, phosphoric acid or potash as the case may be, as is contained in the 5 tons of farmyard manure. Each plot has an area of exactly one-tenth acre. The average yields are given in table No 8.

There is another permanent manurial experiment on the farm which is interesting in that it confirms the conclusion that the application of nitrogenous manures will increase the yield of wheat on poor land here. The original intention was to ascertain the economical value of such manuring; but although the crop has in almost all years been increased, the increase is usually insufficient to cover the cost of the treatment and of late years has resulted in a considerable deficit. The land is cropped with wheat every year, and the manure is applied every year. The land is poor and affected by kallar. Results are given in Table No. 9.

Table No. 8.

SQUARE 24—MANURIAL EXPERIMENT—AVERAGE YIELDS.

AREA F-1.

Plots.	Manure.	Maize, 1918.	Barley, 1918-19.	Cotton, 1919.	Maize, 1920.
1 and 9	Farmyard, 5 tons	21·6	13·5	6·5	...
2 and 10	Sodium Nitrate 310 lbs.	30·6	12·6	5·6	...
4 and 12	Bonemeal, 200 lbs.	17·7	6·9	4·0	...
5 and 13	Potassium Sulphate, 90 lbs.	14·3	6·8	3·2	...
7 and 15	Complete artificials	25·3	18·9	5·6	...
3, 6, 8, 11, 14, 16	Unmanured	17·5	5·8	4·4	...

AREA F-2.

Plots.	Manure.	Maize, 1918.	Senji, 1918-19.	Cotton, 1919.	Maize, 1920.
1 and 9	Farmyard, 5 tons	19·4	49	6·0	...
2 and 10	Sodium Nitrate, 300 lbs.	26·6	45	5·0	...
4 and 12	Bonemeal, 300 lbs.	17·8	50	6·0	...
5 and 13	Potassium Sulphate, 90 lbs.	19·6	50	6·0	...
7 and 15	Complete artificials	22·5	44	14·7	...
3, 6, 8, 11, 14, 16	Unmanured	16·9	50	7·9	...

MANURING WITH SODIUM NITRATE IN SQUARE 7; FIELDS 8 AND 9.

Table No. 9.

MANURING WITH SODIUM NITRATE IN SQUARE 7, FIELDS 8 AND 9.

Year.	Treatment.	Number of plots.	Area of each plot	Yield per acre.	Increase (+) decrease (−) apparently due to the manure applied.
			Acre.	Maunds.	Maunds.
1910-11 ...	Unmanured	1	½	9·4	+2·8
	1½ Cwt. Sodium Nitrate	...	...	12·2	
	Unmanured	1	½	9·1	+2·8
	1 Cwt. Sodium Nitrate per acre	...	...	11·9	
1911-12 ...	Unmanured	1	½	14·4	+4·0
	1½ Cwt. Nitrate	...	...	18·4	
	Unmanured	1	½	15·0	+5·8
	1 Cwt. per acre	...	...	20·8	
1912-13 ...	Unmanured	1	½	10·4	+6·9
	1½ Cwt. Nitrate	...	...	17·3	
	Unmanured	1	½	13·9	+3·5
	1 Cwt. Nitrate	...	...	17·4	
1913-14 ...	Unmanured	1	½	7·1	+2·3
	1½ Cwt. Nitrate	...	...	9·4	
	Unmanured	1	½	8·8	+2·9
	1 Cwt. Nitrate	...	...	11·7	

1914-15	...	Unmanured	...	...	...	...	1	½	11·1	+3·8
		1½ Cwt. Nitrate	...	...	...	...	...	...	14·9	
		Unmanured	...	...	...	...	1	½	11·8	+2·5
		1 Cwt. Nitrate	...	...	...	...	...	...	14·3	
1915-16	...	Unmanured	...	...	...	...	1	½	11·9	+6·7
		1½ Cwt. Nitrate	...	...	...	...	...	...	18·6	
		Unmanured	...	...	...	...	1	½	16·1	+2·7
		1½ Cwt. Nitrate	...	...	...	...	...	...	18·8	
1916-17	...	Unmanured	...	...	...	...	1	½	13·3	+·5
		1½ Cwt Nitrate	...	...	...	...	...	...	13·8	
		Unmanured	...	...	...	...	1	½	8·9	+4·8
		1 Cwt. Nitrate	...	...	...	...	...	...	13·7	
1917-18	...	Unmanured	...	...	...	...	1	½	16·9	+·6
		1½ Cwt. Nitrate	...	...	...	...	...	...	17·5	
		Unmanured	...	...	...	...	1	½	9·0	+5·0
		1 Cwt. Nitrate	...	...	...	...	...	...	14·0	
1918-19	...	Unmanured	...	...	...	...	1	½	8	+3·4
		1½ Cwt. Nitrate	...	...	...	...	...	...	11·4	
		Unmanured	...	...	...	...	1	½	13.8	—4·2
		1 Cwt. Nitrate	...	...	...	...	...	...	9·6	
1919-20	...	Unmanured	...	...	...	...	1	½	13·5	+6·7
		1½ Cwt. Nitrate	...	...	...	...	...	...	19·2	
		Unmanured	...	...	...	...	1	½	14·9	+7·0
		1 Cwt. Nitrate	...	...	...	...	...	...	21·7	

Green Manuring.

The result of manurial experiments have shown that the only effective manures are farmyard manure, or artificial nitrogenous manures. In the present local conditions, however, the former is scarce and the latter are dear. In these circumstances it would appear that green manuring, by ploughing in a leguminous crop, might be a profitable way of improving poor land, or perhaps even maintaining the fertility of good land. If the cost of the manure be reckoned at the value of a crop, which could have been grown with the water and labour used for growing the crop to be ploughed in, then this is an expensive process, but it has been suggested that sometimes, during the summer months, there is land and a little water to spare, and the growth of a green manuring crop may be a practical way of using these economically. During the last ten years a number of experiments have therefore been carried out dealing with various aspects of this problem.

(1) One problem which obviously immediately arises is that of the best crop to plough in. All the most suitable crops have been tested and the results have shown that Guara (*Cyamopsis Psoraloides*) and Sann (*Crotolaria juncea*) are the best; and of these two the former not only gives the better results, but is also more easily and conveniently grown.

(2) A number of tests have been made in order to ascertain whether it is absolutely necessary to plough the whole of the leguminous crop into the soil, or whether any benefit resulted from the growth of the leguminous crop, even though the parts above ground be removed from the field. In these experiments a leguminous crop is grown in summer, and removed or ploughed in as the case may be: the effect is seen in the yield of wheat in the following winter. The results have shown that growing and removing a summer leguminous crop before wheat is sown, lowers the yield of the wheat as compared to the effect of a proper summer fallow before the wheat.

An experiment on small plots at the Student Farm may be quoted :—

Treatment in Kharif.	No. of plots.	Area, of each plot.	yield of wheat, 1918-19.	1919-20.
		Acre.	Mds. per acre.	Mds.
Fallow	4	1/20	9·4	8·5
Guara harvested ...	4		6·7	7·8
Guara ploughed in ...	4		10·5	13·5
San ploughed in ...	4		8·7	10·0

and the following experiments on ½ acre plots in the tenants area (13-19-22) confirms the above, although there is no fallow control plot in this test. The yield given is the average of the three years 1917-18 to 1919-20.

——	Number of plots annually.	Average yield
Wheat after San ploughed in ...	4	14·7
„ „ **Guara** „ „ ...	2	16·1
„ „ **Guara removed** ...	2	9·4

(3) Lastly a number of tests have been made at different times to ascertain the degree of improvement which may be expected to result from this treatment. The results have been very variable ; some have been very encouraging, others quite the reverse.

As examples of the former, may be mentioned the green manuring of the field B in Square 26, which has always been apparently very beneficial as is shown by the following record :—

—	Green manure crop.	No. of waterings.	Winter crop.	Average yield per acre.	No. of waterings.
1909-10	*Nil*	...	Barley	3·9	...
1910-11	San (Hemp)	*Nil*	Do.	16·7	2
1911-12	*Nil*	...	Gram	20·4	*Nil*
1912-13	San (Hemp)	2	Barley	26·5	2
1913-14	*Nil*	...	Gram	15·1	*Nil*
1914-15	*Nil*	...	Barley	17·4	4
1915-16	*Nil*	...	Gram	19·8	*Nil*
1916-17	*Nil*	...	Barley	8·6*	3
1917-18	*Nil*	...	Gram	23·9	1
1918-19	*Nil*	...	Barley	15·6	3
1919-20	Guara	*Nil*	Barley	22·3	2

(*) Crop damaged by hail to an extent estimated at 10 per cent.

Again, in addition to the experiment on the Students' Farm, which has been referred to above, another experiment has also been carried out in small plots in the same way, in which the average results in the five years 1914-1918-19 have been as follows :—

Wheat	after	San ploughed in	21·8	mds. per acre.
,,	,,	Summer fallow	16·8	,,
,,	,,	Guara ploughed in	25·3	,,

Green manuring with Guara annually has increased the annual wheat crop by one-half; and green manuring with San has increased it by one-third.

On the other hand there have been several cases where the green manured land has not yielded more than land fallowed and well cultivated during the summer. Some of these experiments have been made on excessively poor and variable land affected with patches of kallar (incrustation of alkaline salts); so that the apparent failure of the process may have been due to the enormous experimental error, or to the very poor crop which it has been possible to grow for ploughing in, under such circumstances. This, however, hardly explains some of the cases, in which it would seem that some other factors, unknown at present, may be involved. In this category the following experiment may be quoted :—

Square and field.	Treatment in Summer 1918.	No. of plots.	Area of each plot.	Average yield of wheat per acre, 1918-19.
7/12 ...	Fallow	2	¼ acre	15·5
	Guara ploughed in	2	...	15·8

Other aspects of the problem are now being attacked. Area A-3, in square 26, is expected to provide figures showing the economics of green manuring regularly in a proper practical rotation; and in area B the effects of green manuring early or late in the summer are being compared. At the same time the Agricultural Chemist is studying the Chemistry and Bacteriology of the process, in the hopes of discovering the factors governing the exact effect on the soil of applying the green manure, and also the factors affecting the increase in the nitrogen content of the soil during ordinary summer fallowing with which manuring has to be compared: for the efficiency of summer fallowing also seems to vary very greatly from unknown causes.

Ploughing.

Iron furrow turning ploughs have been introduced into the Province with some degree of success. There can be no doubt that these ploughs are great labour saving devices as compared to the country plough. Experiments have shown that one ploughing with the iron plough is more than equivalent to two with the country plough. It has, however, also frequently been suggested that the local methods are deficient in that the cultivation is too shallow and that the preparation of the soil for the next crop does not start soon enough after the removal of the last.

Deep ploughing.

An experiment on this point has been started in square 27. There are three kinds of plots in this trial. In the "control" plots the soil is ploughed to a depth of 5½-6 inches by means of the small iron furrow-turning plough ("Rajah" plough) ordinarily used here. The "deeply ploughed" plots are ploughed to a depth of about 9 inches by means of a large furrow-turning plough. This very badly destroys the level of the soil, and the re-levelling is very laborious; so that it is extremely doubtful whether it would be practicable to plough to this depth regularly before every crop, as is done in this experiment. In preparing the "deeply stirred" plots the ordinary Rajah plough, working to a depth of 6 inches, is immediately followed by a country plough which only stirs the soil to a further depth of about 3 inches. This does not disturb the level of the field any more than ordinary ploughing with the small iron plough. The rotation is to be wheat, maize and American cotton. The rotation gives 100 per cent. intensity, and allows time for re-levelling the land after the different treatments before the crop. None the less it should be a distinctly exhaustive rotation. Previous cropping of the plots showed that they are very comparable, if compared in the way in which they are arranged in this experiment though there is a difference in the two sides of the field. For results to date see Table No. 10. The wheat crop on the deeply cultivated plots look slightly more healthy in the early stages, but so far there has been little difference in the yields.

The effect of early ploughing.

At one time it was suggested that the yield of the winter wheat crop in the plains of India greatly depended on the date on which the land received its first ploughing in the summer. As a matter of fact zamindars always do try to plough land as early as possible in the summer ; and a recommendation to do so, would possibly not be of great utility. However, an attempt has been made to obtain some idea of the real importance of this point. The land on which the experiment is conducted is not very uniform, but the plots are large (each approximately one acre) and there are four of each kind. After continuing the experiment for eight years, in order to eliminate any difference in the nature of the soil, the plots have now been interchanged so that those previously ploughed early are now ploughed late, and *vice versa*. The early ploughing is done by the aid of irrigation water, whereas the late fields are ploughed after the first good fall of rain in the monsoon. But by waiting for this rain the land for late ploughing is sometimes left longer than any farmer leaves his wheat land unploughed in actual practice.

The figures so far indicate that the practice of early ploughing is beneficial, but that the importance of ploughing a little earlier in the season may easily be overestimated. If the ploughing is left till very late in the season this is markedly detrimental.

The yields on the whole are not very good : for the land is not very good, and with the continued growing of the same crop it is becoming infested with weeds. The results are given in Table No. 11.

Table No. 10.

DEEP CULTIVATION EXPERIMENTS (IN SQUARE 27 D.).

Year	Crop.	Plots.	Treatment.	Number of plots.	Area of each plot.	Number of watering after sowing.	Average yield (grain).	Average increase (+) or decrease (—) apparently due to deeper cultivation.	
					Acre.		Mds. per acre.	Mds. per acre.	
1918-19 ...	Wheat ...	1a. 3a ...	Ploughed 6″ deep ..	2	¼	2	17·0	+ 6	+ 3½
		2a, 4a ...	Ploughed 6″ stirred a further 3″	...	...	...	17·6		
		5a, 7a ..	Ploughed 6″ deep ..	2	¼	2	17·7	+ 3·9	+ 22
		6a, 8a ...	Ploughed 9″ deep ...	...	...	...	21·6		
		1b, 3b ...	Ploughed 6″ deep ...	2	¼	3	20 7	—·1	—½
		2b, 4b ...	Ploughed 6″ deep and stirred...	...	...	...	20·6		
		5b, 7b ...	Ploughed 6″ deep ...	2	¼	3	20·3	+ 3·0	+ 15
		8b, 8b ...	Ploughed 9″ deep ...	...	...	...	23·3		
1919-20 ...	Wheat ...	1, 3 ...	Ploughed 6″ deep ...	2	½	3	38·7	+ ·8	+ 2
		2, 4 ...	Ploughed and stirred ...	...	...	...	39·5		
		5, 7 ...	Ploughed 6″ deep ...	2	½	3	39·0	0	0
		6, 8 ...	Ploughed 9″ deep ...	...	...	...	39·0		

Table No. 11.

EARLY AND LATE PLOUGHING FOR WHEAT.

Year.	Number of waterings after sowing.	Hot weather ploughing. Average yield. Grain.	Hot weather ploughing. Average yield. Bhusa.	Rains ploughings. Average yield. Grain.	Rains ploughings. Average yield. Bhusa.	Dates of hot weather ploughing.	Date of rains ploughing.	Average difference in dates of ploughing days.	Increase (+) or decrease (−) in grain apparently due to early ploughing. Mds. per acre.	Increase (+) or decrease (−) in grain apparently due to early ploughing. Percentage.	Increase (+) or decrease (—) in Bhusa apparently due to early ploughing. Mds.	Increase (+) or decrease (—) in Bhusa apparently due to early ploughing. Percentage
1910-11	3·4	13 5	32·1	12·3	25·3	May 24th ... June 8th, 20th	July 22nd, 25th ...	45	+1·2	+10	+6·8	+27
1911-12	4	17·3	44·3	15·8	31·4	May 22nd, 23rd ...	September 1st, 2nd	102	+1·5	+10	+12·9	+41
1912-13	4	16·9	33·8	13·7	26·4	May 3rd, 4th ...	Ditto	121	*+3·2	+23	+7 2	+28
1913-14	2	5·7	18·3	5·5	13 0	May 21st, 22nd ...	June 3rd, 4th ...	12	+·2	+4	+3·3	+25
1914-15	3	13·2	31·9	12 0	29·0	May 14th ...	June 30th ... July 1st.	47	+1·2	+10	+2·9	+10
1915-16*	4	16 1	3 ·0	*11·8	28·8	May 5th, 7th ..	September 21st, 24th	139	+4·3	+37	+4·2	+15
1916-17 ...	2	11·3	20·7	10·5	18·8	April 28th, 30th	August 12th, 14th	106	+ 8	+7½	+1·9	+18
1917-18	3	9·9	22·8	12·5	22·1	May 13th, 14th ...	August 9th, 12th	89	−3·6	−27	−·7	—3
Average 1910—1918 excluding 1915-16.	...	12·5	29	11·8	24	...	...	42	+1·7	+98	+5	+21
1918-19	3	17·1	32·9	16 2	30 2	May 28th, 29th ...	August 23rd ...	87	−·9	—6	—2·7	—9
1919-20	3	15 4	31·7	17·5	37·1	June 10th, 11th ...	August 1st, 2nd ...	52	—2·1	—12	—5·4	—15

*In 1915-16 the rains failed completely and the late ploughing was done much too late in September.

Harrowing.

It is somewhat remarkable that the farmers of the canal colonies have no implement to serve the purpose of a light harrow to use on a young growing crop; especially in view of the rapidity with which the local soils form a thin crust on drying. The need for the heavy harrows and cultivators used in western agriculture for preparing land for sowing is not so hardly felt: for it is almost always possible to make a perfect seed bed by using only the country implements, and the chief utility of western implements in this connection is the saving of labour which they make possible. But when the crop has been sown, the lack of any sort of light harrow, fit to cover a wide area quickly, is a real handicap In the most favourable circumstances, so much labour is wasted on hand hoeing small areas that much of the growing crop is untouched, or not cultivated enough. But worse than this, when rain falls on very young crops, very serious damage may result from the complete inability of the farmer to break up the crust that forms on all fields. Under these circumstances it is not surprising that the cheap and simple "Bar" harrows introduced at Lyallpur are being very rapidly adopted by local farmers. Harrows can be used on many crops, but actual experiments to show the effect on yield, have been confined to the two or three most important crops.

Wheat.

Ordinarily in these colonies after wheat has been sown the land is levelled with the *sohaga*. But although the *sohaga* leaves the surface compressed and somewhat "pasted," the soil does not generally crust badly until the first irrigation, for the temperature at this time is not exceedingly high; and moreover the seed bed for winter crops is allowed to become somewhat drier before the seed is sown. On the other hand, after the first irrigation (called *kor*), the surface of the soil eventually becomes very hard indeed, and it might well be thought that breaking this hard surface with a harrow would be very beneficial to the growing crop. Experiments in which the yield of harrowed and unharrowed crops were compared have been going on for several years. The results are given in Table No. 12.

In some cases the effect of harrowing is very markedly beneficial. For instance, 1918-19, rain fell as the crop was germinating. The harrowed plots, where a harrow had been used directly after the *sohaga*, were again harrowed as soon as the crop was high enough. The result was an increase of 4 maunds per acre. The two harrowings would cost perhaps 8 annas per acre, and without a harrow a farmer would probably have been unable to get this work done at any cost.

But in most years, although the young plants appear to benefit by the harrowing, this benefit is not apparent in the result. This is remarkable and was unexpected. However, the harrowing is worth while, even if it does not benefit the crop at all: for many young weeds are killed, and if this is done every year, it must have an effect in time. The latter effect does not come into this experiment, as the land used for it is very clean; but it is important under ordinary conditions.

Toria.

It is hardly possible to harrow this crop after germination; but it would seem that considerable benefit should result from using the harrow directly after sowing (following the *sohaga*). For the germination of toria in *zamindars'* field is often very irregular; and small scale careful experiments have shown that the germination is greatly improved by breaking the smooth surface left by the *sohaga*. A number of large scale experiments have therefore been made in which the yields of plots so harrowed is compared with the yield of plots not harrowed. In this experiment it is always obvious that the germination is improved by the harrowing. In one year (1917-18) when rain fell soon after the field was harrowed, the yield was also increased. But in other cases the benefit is not apparent in the yield. Probably with the very careful methods adopted on land under direct cultivation at Lyallpur, a sufficiently thick germination is obtained even without harrowing. Where the cultivation is less careful the harrowing will undoubtedly improve the yield. Zamindars, employing generally less care in their processes than we do, usually secure but a moderate germination of this crop. The results of the experiments are given in Table No. 13.

Sugar-cane.

In the best local practice, sugar-cane receives two to four cultivations with various hand tools. On this crop the harrow can thus chiefly be useful in the saving of labour. Experiments have recently been started in which harrowing is compared with hand cultivation.

Table No. 12.

EXPERIMENTS IN HARROWING WHEAT.

Year.	Square and field.	Treatment	Number of plots.	Area each plot.	Number of waterings after sowing.	Number of harrowing after sowing.	Average yield.	Average increase (+) and decrease (−) apparently due to harrowing.		Remarks.
1916-17	27/C 3	Not harrowed ...	3	¼ acre	3·2	...	32·1	—2·6	— 8	No rain between sowing and first irrigation on Jannery 26th.
		Harrowed	3		3·2	...	29·5			
1917-18	27/C 2	Not harrowed	4	¼ acre	2	...	22·5	+ 3	+ 1	Sown, December 9th, ·43 in rainfall, December 13—15.
		Harrowed	4		2	3·2	22·8			
1918-19	27/C 1	Not harrowed	4	¼ acre	2	...	24·5	+ 4·2	+ 16	
		Harrowed	4		2	3	28·7			
1919-20	27/C 3	Not harrowed	4	¼ acre	1—2	...	37·8	— ·5	— 1	
		Harrwed	4			1	37·1			

Table No. 13.

EXPERIMENTS IN HARROWING TORIA DIRECTLY AFTER SOWING.

Year.	Square and field.	Variety of toria.	Treatment	Number of plots.	Area of each plot.	Number of waterings.	Average yield.	Average increase (+) or decrease (—) apparently due to harrowing.	
							Md.	Mds.	%
1917-18	26 A_5	Local	Not harrowed ...	6	¼ acre	2	11·9	—1·0	—8
			Harrowed ...				10·9		
	32 C	Local	Not harrowed ...	8	½ acre	3	12·8	+ ·2	+2
			Harrowed ...				13·0		
1918-19	26 A_3	Local	Not harrowed ...	6	¼ acre	2	10·9	— ·1	—1
			Harrowed ...				10·8		
	32 D	Local	Not harrowed ...	6	¼ acre	1	12·1	+ ·2	+2
			Harrowed ...				13·3		
1919-20	26 A_4	Early	Not harrowed ...	6	⅛ acre	3	10·9	—1·7	—16
			Harrowed ...				9·2		
	26 A_4	Late	Not harrowed ...	6	⅛ acre	2	8·9	— ·3	—3
			Harrowed ...				8·6		
	Tenant area.	Early	Not harrowed ...	4	¼ acre	3	13·0	+1·5	+11
			Harrowed ...				14·5		
	Do.	Late	Not harrowed ...	4	¼ acre	3	14·2	+ ·3	+2
			Harrowed ...				14·5		
	43	Early	Not harrowed ...	6	⅛ acre	3	14·4	...	...
			Harrowed ...				14·4		
		Late	Not harrowed ...	6	⅛ acre	3	13·7	+ ·3	+2
			Harrowed ...				14·0		
		Local	Not harrowed ...	6	⅛ acre	3	13·6	+ ·7	+5
			Harrowed ...				14·3		

Time of sowing.

As the season in the Punjab changes very rapidly in the autumn, the time at which wheat and toria are sown greatly affects all the conditions of their growth. The results of many experiments, such as irrigation and varietal tests, are therefore liable to be affected by the time at which the crop is sown, and it has been necessary to duplicate them with early and late sowings. In this way figures have been collected showing the effect of the time of sowing on the yield of these crops. The results may not be of much direct importance to farmers, for they all know the importance of sowing in good time ; but actually, owing to limitation of the water supply, etc., it is in practice impossible to sow all fields at the same time. Thus for each square of 27 acres enough water is received from the canal at each " wari " to water some four acres. As each square grows 14 acres or so of wheat, and the " wari " takes 10 or 12 days, and some water must be used for other crops, so all the wheat cannot be sown in less than six weeks at the best. Still the figures given in Table No. 14 are interesting and significant.

In the examples (Table No. 14) of early and late sown wheat given, the blocks are strictly comparable and the date of sowing is the only cause of the difference in yield (apart of course, from those variations of soil which can never be entirely avoided). Similar differences are frequently observed in cases where the early and late sown blocks, though not strictly comparable, are yet known not to differ greatly in fertility.

In the case of toria the effect of late sowing is very variable, causing great diminution in the yield in some years and very little in others—see Table No. 15.

Table No. 14.

EARLY AND LATE SOWN WHEATS.

Year.	Square and field.	Variety of wheat.	Number of plot.	Area of each plot.	Number of waterings after sowings.	Dates of sowing.	Difference in dates.	Average yield per acre.	Average increase (+) or decrease (−) apparently due to early sowings.	
				Acres.			Days.	Mds.	Mds.	Per cent.
1917-18 ...	$\frac{10}{Bb}$	Punjab 11 ...	4	¼	2	October 30...	41	14·4	+8·2	+76
	$\frac{10}{Cb}$	Do. ...	4	¼	2	December 11		6·2		
	$\frac{10}{Bb}$	Do. ...	4	¼	3	October 30	41	12·9	+5 8	+62
	$\frac{10}{Cb}$	Do. ...	4	¼	3	December 11		7·1		
1918-19 ...	$\frac{10}{A1}$	Do. ...	4	¼	2	November 10	31	27·3	+5·7	+26
	$\frac{10}{A2}$	Do. ...	4	¼	2	December 11		21·6		
	$\frac{10}{A1}$	Do. ...	4	¼	3	November 10	31	28·9	+5·6	+24
	$\frac{10}{A8}$	Do. ...	4	¼	3	December 11		23·3		
1919-20 ...	$\frac{10}{Ba}$	Do. ...	4	¼	2	October 31	37	30·3	+6·9	+29
	$\frac{10}{Ca}$	Do. ...	4	¼	2	December 7		23·4		
	$\frac{10}{Ba}$	Do. ...	4	¼	3	October 31	37	31·5	+5·7	+22
	$\frac{10}{Ca}$	Do. ...	4	¼	3	December 7		25·8		

Table No. 15.

EARLY AND LATE SOWING OF TORIA.

Year.	Square and field.	Number of plots.	Area of each plot.	Number of waterings after sowings.	Date of sowing.	Difference in dates.	Average yield per acre.	Average increase (+) or decrease (—) apparently due to early sowing.	
			Acres.			Days.	Mds.	Mds.	Per cent.
1917-18 ...	10/Ba	4	¼	1	September 14-15	18	9·3	+4·7	+102
	10/Ca	4	¼	1	October 3 ...		4·6		
	10/Ba	4	¼	2	September 14-15	18	8·3	+2·4	+41
	10/Ca	4	¼	2	October 3 ...		5·9		
1918-19 ...	10/Bb	4	¼	1	September 10 ...	22	8·45	—·65	—7
	10/Cb	4	¼	1	October 2 ...		9·1		
	10/Bb	4	¼	2	September 10 ...	22	8·3	—1·8	—18
	10/Cb	4	¼	2	October 2 ...		10·1		
1919-20 ...	10/A1	4	¼	1	September 1 ...	18	12·9	—2·0	—13
	10/A2	4	¼	1	September 19 ...		14·9		
	10/A1	4	¼	2	September 1 ...	18	13·5	—·7	—5
	10/A2	4	¼	2	September 19 ...		14·2		

Irrigation Experiments.

The object of these experiments, to which much importance is attached at Lyallpur, is to study the relation between the amount of water applied and the yield of the crop, and incidently to find the most efficient frequency, depth and dates for watering. As was mentioned in the chapter on rotations, these experiments, to be at all complete, need to be tried on land treated in various different ways as to rotations and manuring; but at Lyallpur we have so far been forced to restrict ourselves to the broadest aspects of the question under the commonest circumstances.

One square (No. 10) has been set apart for this purpose and the water is supplied to it through a Gibbs' module giving a constant supply of about 1½ cusec. Thus the amount of water given is controlled and measured only by the time taken in irrigating each plot. This method allows of the water being very accurately measured. The area is however too small to allow of sufficient repetition of the different plots, especially as the land is very irregularly affected by "Kallar." An attempt is therefore made to duplicate each experiment on some other part of the farm. A preliminary experiment was undertaken to find the size of "Kiari" which would allow of the lightest watering. The results indicated that with a flow of 1·5 cusecs the smallest watering can be given with eight Kiaris to the acre; and that with this flow when the land is fairly accurately levelled four Kiaris is more effective than sixteen; but the reverse is the case if the land is unlevel. The case would probably be different if the flow were larger or smaller than 1·5 cusecs.

Watering of Wheat.

The experiments with this crop have so far been restricted to attempting to find the minimum number of waterings which will give a maximum, or practically a maximum, crop of grain. As the experiments which can be successfully undertaken each year are strictly limited by the areas available, the experiments each year are limited to testing one against two, two against three, or three against four waterings, one of these comparisons only being attempted each year. Three and four waterings were compared in the early years; and in this Province it is seldom possible to give only one watering to wheat on light land on account of the way in which white ants devastate a crop which is starved to this extent. Repeatedly experiments in which it was intended to give only one watering have had to be modified on this account. Thus most of the recent experiments consist of comparisons of two and three waterings. It may be mentioned that three waterings is the generally accepted minimum for growing a good wheat crop in this province; and that this is confirmed by the results of some very useful experiments carried out by theI rrigation Department some few years ago.

Thoroughly to establish the result of even this simple comparison is not a small work. For if the two waterings be given at what are considered to be the best dates, there are four distinctly different ways in which the third watering may be added. It may—

(A) be given before the other two, or

(B) between them, or

(C) after them or lastly

(D) the three waterings may be distributed through the season in the way which appears likely to the experimenter to give the best result; in which case probably none of the dates will coincide with those at which the two are given.

Three methods (A, C, D) have been tried at the farm, see Tables Nos. 16, 17, 18. Method B is now being tried. But also the effect of the extra watering might depend partly on the time of sowing, and thus it has been necessary to duplicate the experiments with early and late sowings. Lastly, the climate varies from year to year in at least two important respects—the rainfall, and the temperatures especially at the end of the season, when wheat which is starved of water is liable to shrivel more if the temperatures be high. If all this be considered it will be seen that safe conclusions, on even such a simple point as the "best number of waterings for wheat," cannot be drawn from a few isolated experiments.

The results indicate that as a general and safe allowance that will cover most cases, three must be accepted as the least number of ordinary waterings for wheat. Quite often a maximum crop can be grown with two, but there are cases in which the third watering has a very important effect. And in considering these experiments it must always be remembered that where only two waterings are given, these are given, as far as possible, at the optimum times. Every field, even on our own farm, cannot be watered exactly when it seems desirable, and sometimes a difference of ten days or a fortnight is very important. As already mentioned the water supply cannot be increased and in order to use the water as supplied, it is often necessary to water some fields too early. This generally makes the third watering unavoidable.

Table No. 16.

XPERIMENTS—WATERING WHEAT, CLASS A.

Year.	Rainfall during the growth of crop.	Square and field.	Variety of wheat.	Date of sowing.	Number of waterings after sowing.	Dates of waterings.	No. of plots.	Area of each plot.	Average yield of grain per acre.	Average increase (+) or decrease (−) in grain apparently due to extra watering.		Average yield of bhusa per acre.	Average increase (+) or decrease (−) in bhusa apparently due to extra watering.	
	Inch.							Acre.	Mds.	Mds.	Per cent.	Mds	Mds.	Per cent.
1914-15	2·5	10/B	Punjab 11	October 30th...	Three	December 30th... February 20th... April 2nd ...	2	¼	13·8	+·1	+1	28·8	+1·9	+7
					Four	December 3rd, 31st. February 20th ... April 2nd ...	4		13·9			30·7		
1915-16	1·0	10/Aa	Ditto	November 9th	Three	Februsry 20th... March 13th ... April 1st ...	2		32·4	—·7	—2	62·4	+13·1	+12

1918-19	3·2	$\frac{}{A1}$	Ditto	November 10th	Fuor	January 6th ...	4	½	31·7			75·5		
						February 20th ...								
						March 13th ...								
						April 1st ...								
					Two	February 14th...	4	½	27·3	0	0	60	+4·4	+7
						March 20th								
					Three	January 3rd ...	4		27·3			64·4		
						February 14th...								
						March 20th ...								
	3·2	$\frac{10}{A2}$	Ditto	December 11th	Two	February 24th...	4	½	21·6	0	0	46·8	−9·4	−20
						March 20th ...								
					Three	January 22nd ...	4		21·6			37·4		
						February 14th...								
						March 27th ...								
	3·2	$\frac{27}{D}$	Ditto	October 8th ...	Two	February 17th...	8	½	19·1	+1·5	+8	32·5	4·7	+15
						March 26th ...								
					Three	January 25th ...	8		21·6			37·2		
						February 17th...								
						March 26th ...								

Table No. 16—*concluded.*

Year.	Rainfall during the growth of crop.	Square and field.	Variety of wheat.	Dates of sowing.	Number of waterings after sowing.	Dates of waterings.	No. of plots.	Area of each plot.	Average yield of grain per acre.	Average increase (+) or decrease (—) in grain apparently due to extra watering.		Average yield of bhusa per acre.	Average increase (+) or decrease (—) in bhusa apparently due to extra watering.	
	Inch.							Acres.	Mds.	Mds.	er cent.	Mds.	Mds.	
1918-19 *concld.*	3·2	32/B	Punjab 11	November 16th	Two	January 28th ... March 12th ...	6	⅛	25·4	+2·0	+8	57·3	+·2	—
					Three	January 4th, 28th March 12th ..	6		27·4			57·5		
		32/B	Pusa 12...	November 16th	Two	January 28th ... March 12th ...	6	⅛	24·3	+·7	+3	46·7	—1·5	—3
					Three	January 4th, 28th March 12th ...	6		25·1			45·2		

Table No. 17.

EXPERIMENTS IN WATERING WHEAT CLASS C.

Year.	Rainfall during growth of crop.	Square and field.	Variety of wheat.	Dates of sowing.	No. of waterings after sowing.	Dates of waterings.	No. of plots.	Area of each plot.	Average yield grain per acre.	Average increase (+) or decrease (—) in grain apparently due to extra watering.		Average yield of bhusa per acre.	Average increase (+) or decrease (—) apparently due to extra watering.	
	Inch.							Acres.	Mds.	Mds.	Per cent.	Mds. per Acre.	Mds.	Per cent.
19.9-20	1·9	10/Ba	Punjab 11	October 31st...	Two	February 2nd, 22nd.	4	¼	30·3	+1·2	+4	56·8	−2·8	−5
					Three	February 2nd, 22nd. March 16th ...	4		31·5			54·		
	1·9	32/C	Ditto	November 1st	Two	December 1st ... February 23rd...	9	⅛	30·1	+2	+7	56·1	−4·7	−8
					Three	December 1st ... February 23rd... March 17th ...	9		32·1			51·3		
	1 9	32/C	8-A ...	November 1st	Two	As above ...	9	⅛	29·5	+1	+3	61·7	−8·2	−13
					Three		9		30·5			52·5		

Table No. 18.

EXPERIMENTS IN WATERING WHEAT (CLASS D).

Year.	Rainfall during growth of crop.	Square and field.	Variety of wheat.	Dates of sowing.	No. of waterings after sowing.	Dates of waterings.	No. of plots.	Area of each plot.	Average yield grain per acre.	Average increase (+) or decrease (−) in grain apparently due to extra watering.		Average yield of bhusa per acre.	Average increase (+) or decrease (−) in bhusa apparently due to extra watering.	
	Inch.							Acres.	Mds.	Mds.	Per cent.	Mds.	Mds.	Per cent.
1916-17	1·15	10	Punjab 11	November 11th	Two	January 25th ...	4	¼	21·7	− ·7	−3	50·9	−5·3	−11
						March 3rd ...								
					Three	December 28th...	4		21·0			45·3		
						February 16th...								
						March 23rd ...								
1917-18	1·23	$\frac{32}{D}$	Ditto	December 7th	Two	February 2nd ...	3	½	6·8	+2·7	+40	21·7	+6·3	+29
						March 20th ...								
					Three	February 4th, 28th.	3		9·5			28·0		
						March 30th ...								

1919·20	1·23	32/D	Pusa 12	December 7th	Two	As above ...	3	½	6·9	—·1	—2	20·0	...	...
					Three		3		6·8			20·0		
	1·23	10	Punjab 11	December 11th	Two	February 10th... March 16th ...	4	¼	8·2	—1·2	—15	21·4	—2·8	—13
					Three	February 3rd ... March 24th ... April 1st ...	4		7·0			18·6		
	1·9	10	Ditto	December 7th	Two	February 22nd... March 16th ...	4	¼	14·4	—1·5	—10	24·1	+2·5	+10
					Three	February 4th ... March 5th ... April 1st ...	4		12·9			36·6		
		32/C	Ditto	December 5th	Two	February 23rd... March 16th ...	9	⅙	24·0	+·2	...	40·5	—·5	...
					Three	February 5th ... March 4th, 30th	9		24·2			40·0		
		32/C	8-A ...	Do.	Two	As above ...	9	⅙	25·1	—1·1	—4	44·0	+4·9	+11
					Three		9		24·0			44·9		

Experiments in watering Toria.

The experiments with Toria are similar to those with wheat, but as it is a question only of two waterings or one, there are only three theoretically possible ways in which the extra watering can be given, *i.e.*,—

(*a*) Early,

(*b*) Late, or

(*c*) the dates of two waterings may be arranged as well as possible without either of the dates coinciding with the date on which the single watering is given to other plots. The last method can hardly be beneficial unless one of the other two is. The results of the experiments are given in Table No. 19.

Table No. 19.

EXPERIMENTS ON WATERING OF TORIA.

Year.	Square and field.	Date of sowing.	Number of waterings after sowing.	Number of plots.	Area of each plo.	Dates of waterings.	Rainfall September–January inclusive.	Average yield per acre.	Average increase (+) or decrease (—) apparently due to extra watering.	
						Class A.				
					Acre.		Inches.		Mds.	Per cent.
1917-18 ...	10/Ba	September 14th ...	One ...	4	¼	November 15th ...	·85	9·3	—1·0	—11
			Two ...	4		October 21st November 15th		8·3		
						Class B.				
1918-19 ...	10/Bb	September 10th ...	One ...	4	¼	October 18th ...	10·43	8·3	— ·1	—1
			Two ...	4		October 18th November 28th		8·4		
	10/Cb	October 2nd ...	One ...	4	¼	November 24th ...	(All in September.)	9·1	+ ·9	+10
			Two ...	4		November 24th January 3rd		10·0		
1919-20 ...	10/A	October 1st ...	One ...	4	¼	October 17th ...	·87	13·1	+ ·4	+3
			Two ...	4		October 17th November 24th		13·5		
	10/A	September 19th ...	One ...	8	¼	November 4th ...	...	14·9	+ ·7	—5
			Two ...	8		November 4th December 2nd		14·2		
						Class C.				
1917-18 ...	10/Ca	October 3rd ...	One ...	4	¼	December 9th ..	...	4·6	...	Crop badly damaged by aphis and frost.
			Two ...	4		November 15th December 18th		5·9	+ 1·3	+28

Watering of Cotton.

The growth of a crop of cotton, especially of American cotton, seems to occur in three distinct stages. From the time of sowing until about the beginning of August the plant grows but quite slowly above ground, and at the end of this time should have grown to a height of about 1½ to 2 feet, and the width of the bushes will be less than this. Then until about the end of September the plants grow very rapidly, becoming more bushy as well as doubling their height, and at the same time they bear their flowers and the young bolls are set. From this time to the end of the year, no further growth occurs but the bolls are maturing and ripening. It seems reasonable to suppose that the requirements of the crop in these different stages will be very different, and it is therefore necessary to study each stage separately.

The experiments so far have not been favoured by the seasons ; for one year there was so much rain as largely to obliterate the differences in watering, and the second year the whole crop at Lyallpur was a partial failure. In the waterings in the early part of the season, the first occasion when water is due according to the scheme is neglected ; thus the plots which it is intended to water every ten days receive no water until twenty days after sowing, and those which are to be watered every twenty days receive their first watering after forty days. So far as can be seen at present it would seem that one watering in June and one in July is the least that will be satisfactory on this poor land, though experience elsewhere on the farm has shown that cotton, growing on good or manured land, can be starved of water until July, and yet give a very heavy crop. It seems doubtful if waterings in excess of two before the end of July will give any sufficient increase in crop to form an adequate return, on any ordinary land. For results of the experiments to date see Table No. 20.

In regard to the waterings during the flowering period, the experiments do not yet warrant any conclusions. For results see Table No. 21.

In regard to watering in the late stage, after the beginning of October, when the bolls are maturing and the cotton ripening, experience seems to show that watering does not affect quantity of the yield very much, but that a watering late in October or early in November has a great effect on the quality of the produce, greatly reducing the proportion of weak fibre and the number of imperfectly ripened seeds. Actual experiments on this point have not yet been undertaken.

Table No. 20.

EXPERIMENTS IN WATERING COTTON "A" BEFORE JULY 25TH.

Year.	and field.	Variety of cotton.	Method of sowing.	Number of waterings before July 25th.	Total number of waterings.	Dates of early waterings.	Rainfall during May, June and July.	Number of plots.	Area of each plot.	Average yield per acre.	Average increase (+) or decrease (—) apparently due to extra water.	
										Mds.	Mds.	Per cent.
1917	10/Ab	"Desi" (G. Sanguineum).	In lines.	One ...	1	July 9th ...	5·7 inch	2	¼ acre	7·2	...	...
				Two ...	2	June 16th ... July 9th ...	...	2	Do.	6·9	— ·3	— 4
				Three ...	3	May 21st ... June 16th ... July 9th ...	...	4	Do.	6·5	— ·7	—10
	32/B	American (4-F.)	In lines.	One ...	1	July 11th ...	...	4	Do.	10·0	...	...
				Two ...	2	June 15th ... July 11th	...	4	Do.	+11·9	1·9	+19

				Three	...	8	May 20th June 15th July 11th	... ...		4	Do.	10·3	+ ·3	+ 3
1918	$\frac{10}{\text{Ca}}$	Desi (Sanguineum).	In lines.	One	...	5	July 3rd	...	·91	2	½ acre	9·9	...	...
				Two	...	6	June 22nd July 3rd	... ...	...	2	Do.	6·3	—3·6	—36
				Three	...	7	May 22nd June 22nd July 3rd	... ...	...	2	Do.	6·5	—3·4	—34
	$\frac{32}{\text{C}}$	American (4-F).	Broadcast.	One	...	5	July 7th	...	...	2	Do.	8·5	...	...
				Two	...	6	June 21st July 7th	... ...	...	2	Do.	7·5	—1·0	—12
				Three	...	7	May 25th June 21st July 7th	.. ... .	...	2	Do.	6·2	—2·3	—21
	$\frac{22}{\text{C}}$	American (4-F).	In lines.	One	...	5	As above ...	...	...	2	Do.	9·4	...	...
				Two	...	6	Do. ...	...	...	2	Do.	8·7	— ·7	— 7
				Three	...	7	Do. ...	...	...	2	Do.	7·5	1·9	—20

Table No. 20—concld.

Year.	Square and field.	Variety of cotton.	Method of sowing.	Number of waterings before July 25th.	Total number of waterings.	Dates of early waterings.	Rainfall during May, June and July.	Number of plots.	Area of each plot.	Average yield per acre.	Average increase (+) or decrease (—) apparently due to extra water.	
										Mds.	Mds.	%
1919	20/Ca	American (4-F).	In lines.	One ...	6	July 10th ...	3·3 inches	2	¼ acre	1·6*	...	...
				Two ...	7	June 11th ... July 10th ...	...	2	Do.	2·1*	...	...
				Four ...	9	May 24th ... June 11th ... July 1st, 10th ...	...	2	Do.	1·8*	...	...
				Eight ...	13	May 1st, 6th, 24th ... June 1st, 11th, 21st ... July 1st, 10th ...	...	2	Do.	1·9*	...	...

1919	32/D	American (4-F).	In lines.	One ...	9	July 7th ...	...	3	¼ acre	·6*	...	...
				Two ...	10	June 10th ... July 7th	...	3	Do.	1·4*	...	...
				Four ...	12	May 20th ... June 10th ... July 7th ...	..	3	Do.	1·4*	...	...
				Eight ...	16	May 11th, 21st, 31st ... June 10th, 20th ... July 1st, 7th ...	...	3	Do.	1·5*	...	...
	Tenant area.	American (4-F).	In lines.	One ...	4	June 8th, 16th ...	...	8	¼ acre	3·2	...	...
				Two .	6	June 8th, 16th ... July 1st, 8th ...	...	8	Do.	3·8	+ ·6	+ 19

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* The American Cotton Crop at Lyallpur was practically a failure in nearly all fields in 1919.

Table No. 21.

EXPERIMENTS IN WATERING COTTON (B) VARIED WATERINGS AFTER JULY 25TH.

Year.	Square and field.	Variety of cotton.	Method of sowing.	Number of waterings July 25th to October 31st.	Total number of waterings.	Dates of waterings July 25th to October 31st.	Rainfall July 25th to October 30th.	Number of plots.	Area of each plot.	Average yield per acre.	Average increase (+) or decrease (—) apparently due to extra waterings.	
							Inches.		Acre.	Mds.	Mds.	Per cent.
1919	32/D	American 4-F	In lines	Three ...	5	July 27th	5·06	2	¼	2·6	...	...
						September 23rd ...						
						October 20th .						
				Four ...	6	July 27th ...	...	2	¼	3·6	+1·2	+46
						September 9th ...						
						October 7th, 20th ...						
				Five ...	7	July 27th ...	...	2	¼	3·6	+1·0	+39
						September 10th, 23rd ...						
						October 7th, 20th ...						

10/B	Ditto	Do.	Nine ...	11	July 27th ... August 14th ... September 3rd, 10th, 16th, 23rd, 30th. October 7th, 13th, 20th ...	...	2	¼	3·4	+ 8	+31
			Three ...	5	July 27th ... September 26th ... October 24th ...	...	2	¼	1·3	...	...
			Four ...	6	July 27th ... September 19th ... October 10th, 24th ...	...	2	¼	1·2	...	...
			Five ...	7	July 27th ... September 12th, 26th ... October 10th, 24th ...	...	2	¼	*1·3	...	...
			Nine ...	11	July 27th ... August 13th ... September 5th, 12th, 19th, 26th. October, 3rd, 10th, 17th, 24th.	...	2	¼	*·9	...	...

*These figures are of little value owing to whole crop failing.

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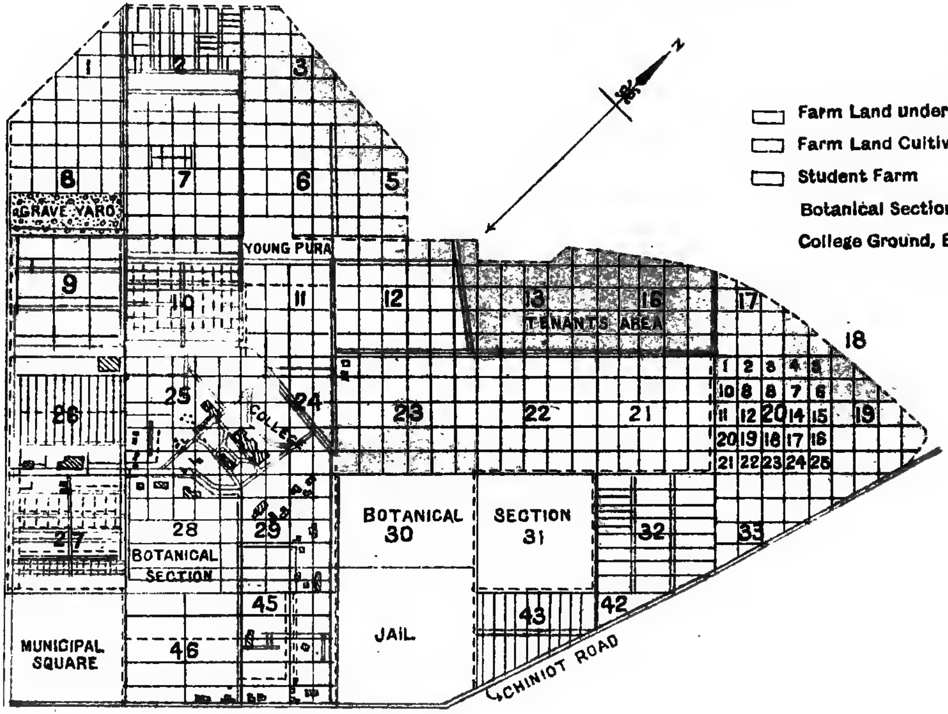
MAP OF AGRICULTURAL ESTATE
LYALLPUR.

Scale—1 Inch = ⅓ Mile.

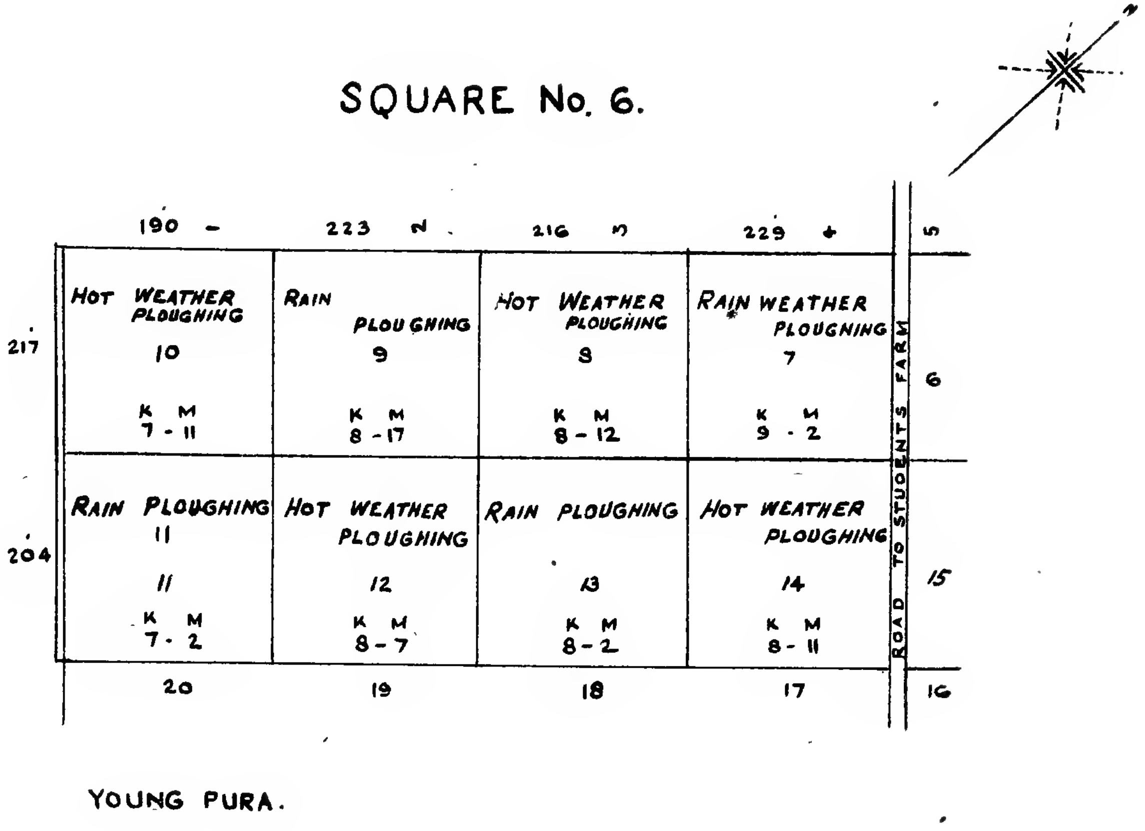


REFERENCES.

▭	Farm Land under Direct Cultivation	250	Acres
▭	Farm Land Cultivated by Tenants	225	„
▭	Student Farm	50	„
	Botanical Section	110	„
	College Ground, Bungalows, Etc.	50	„
	Total	685	„

Photo, Zinco. December, 1920.—No. 1942=500

SQUARE No. 6.



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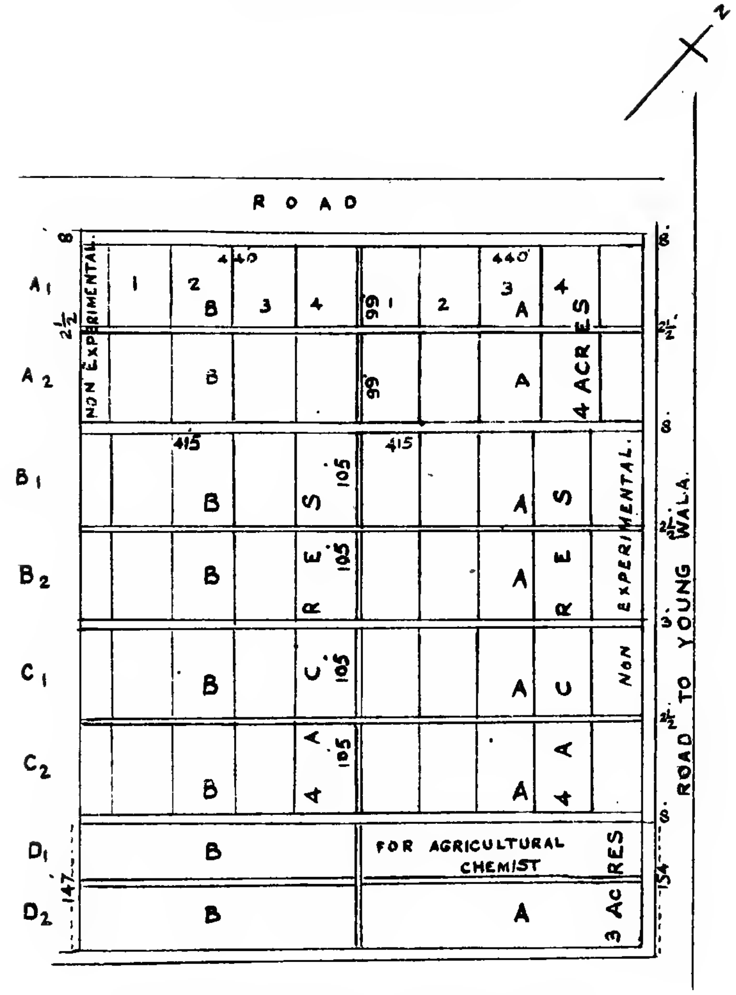

ROTATION - WHEAT - TORIA - COTTON

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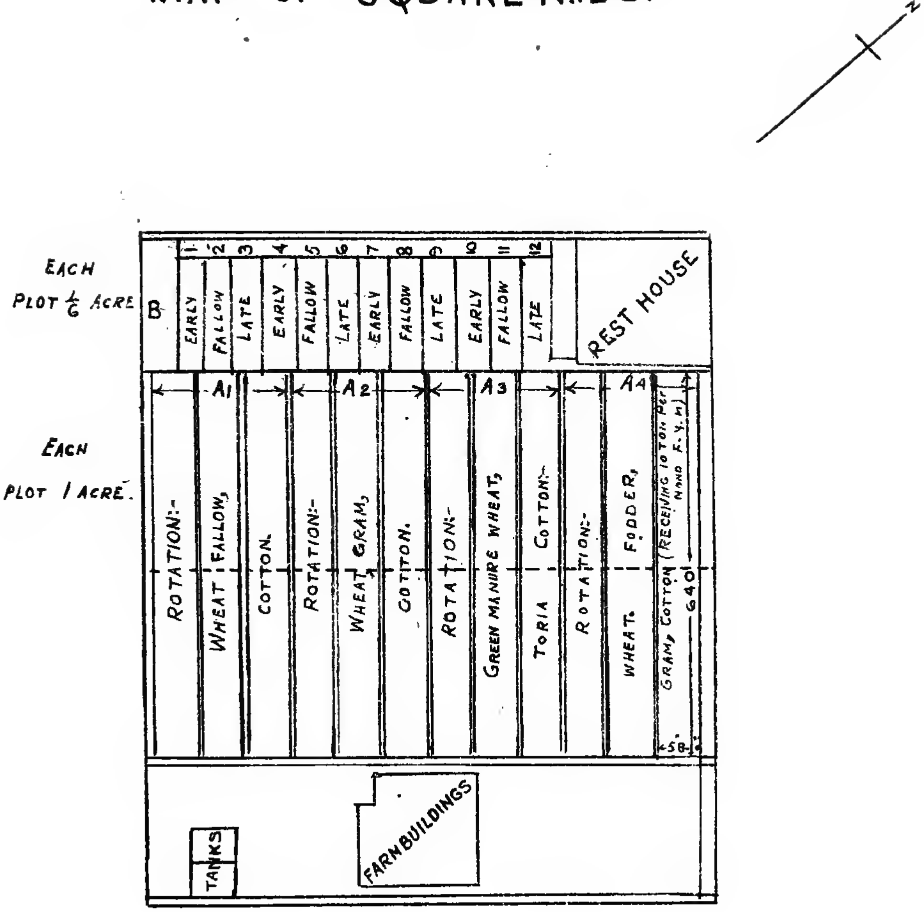
MAP OF SQUARE No. 26.



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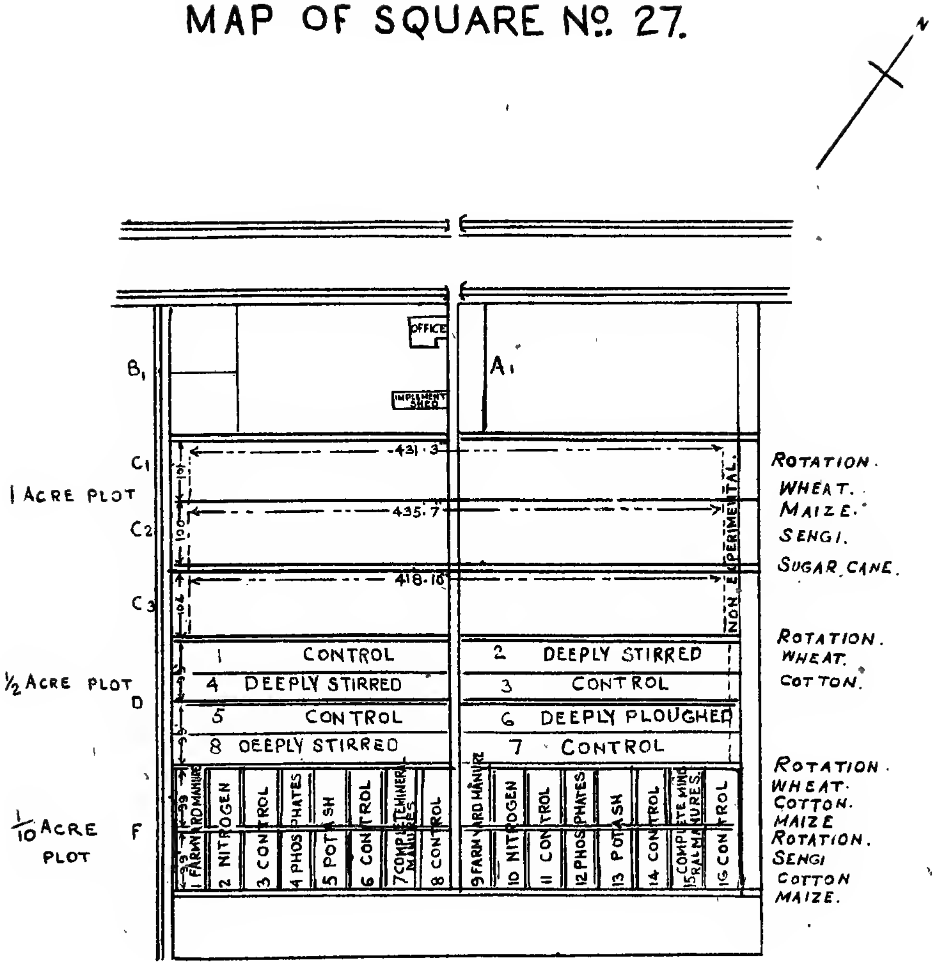
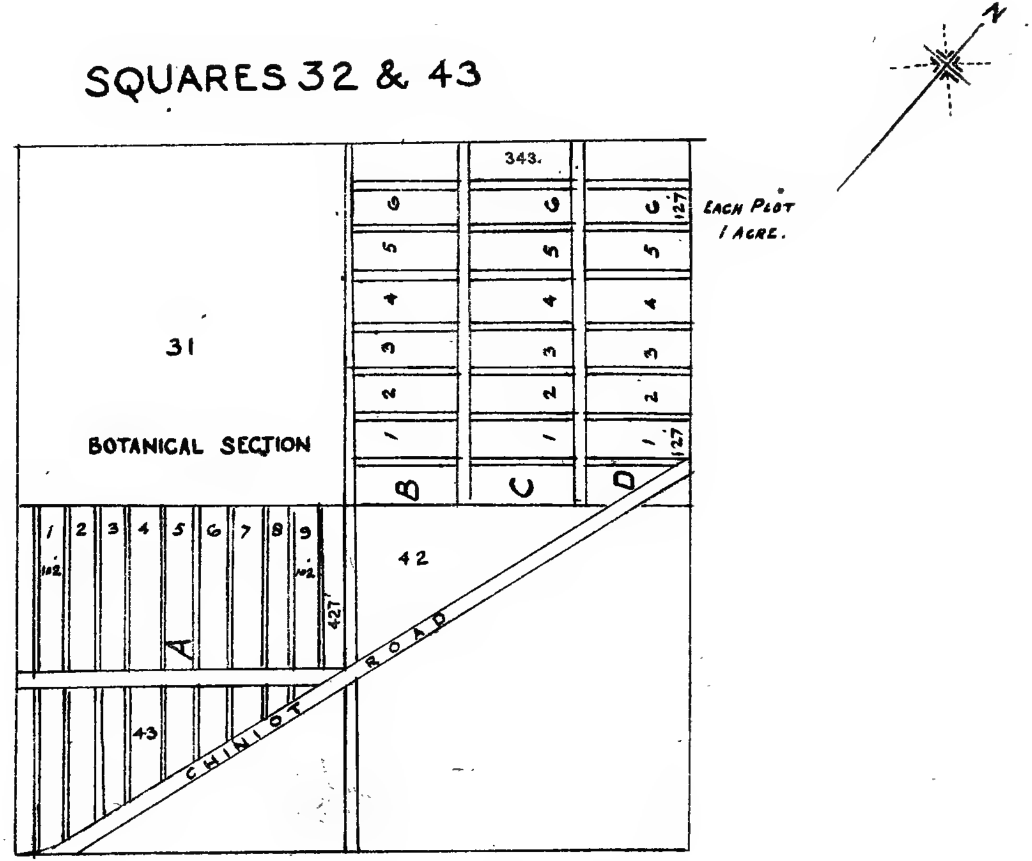


Photo. Zinco., December, 1920.– No. 1942–1=500

SQUARES 32 & 43



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